INVESTIGATION OF ZEEMAN STATE-TO-STATE COLLISION-INDUCED TRANSITIONS IN NITRIC OXIDE USING TWO-COLOR POLARIZATION SPECTROSCOPY

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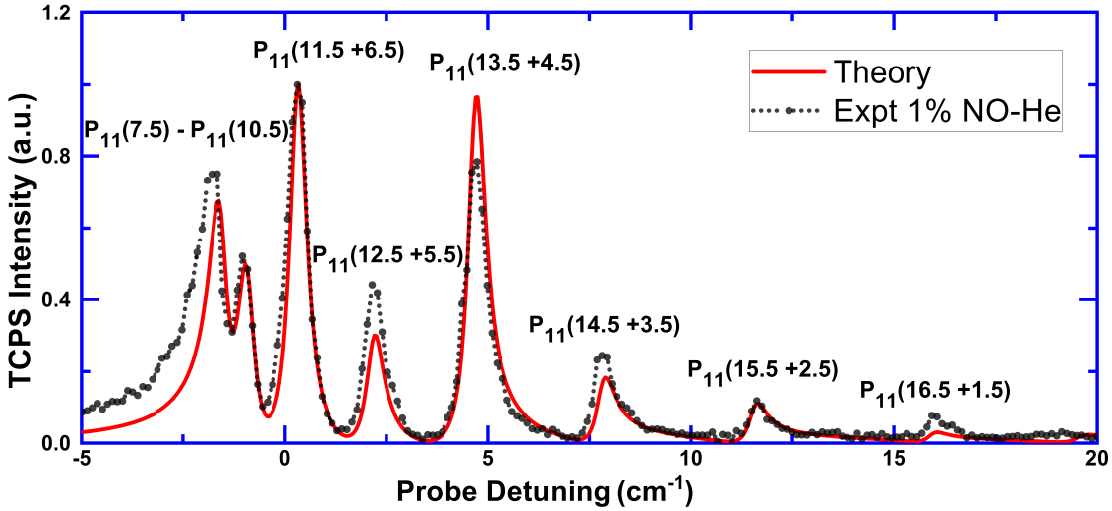
Polarization spectroscopy (PS) is a nonlinear pump-probe technique that utilizes a change in the polarization of the probe beam, due to anisotropic Zeeman state populations created in the target molecule by the pump beam. The line strength and line shape of a PS signal is dependent on the structure and dynamics of the molecule. Here we present a two-color polarization spectroscopy (TCPS) technique, with independent spectral tuning of the pump and probe beams, for investigating collision induced transitions (CITs) in the $A^2\Sigma^+$-$X^2\Pi$ (0-0) band of nitric oxide (NO) at 295 K and 1 atm. We distinguish CITs from shared level transitions (SLTs), which occur when the transitions excited by pump and probe beams share a common upper and/or lower level. In TCPS, CITs only occur when Zeeman state anisotropy (ZSA) is preserved to some extent during state-to-state rotational transfer. In these NO TCPS studies, a circularly-polarized pump beam is tuned to create a ZSA in the NO molecules at either low or high J level. A weak probe beam is then scanned over a range of transitions close to the pump frequency in order to probe SLTs and CITs. Gas mixtures of 1% NO in the buffer gases He, N_2, and Ar were selected for the experiments to investigate the dependence of CIT on collision species. The strongest CITs were observed in the He buffer gas and the weakest CITs were observed in the Ar buffer gas. A time-dependent density matrix model incorporating a modified-exponential-gap-law-based collisional submodel was developed to investigate the state-to-state ZSA retention rate of NO with different colliding partners. A key result is that the spin-flip transition rate in the $A^2\Sigma^+$ level is significant at low J, while being almost zero at high J ($J > 10$). These results will provide useful information for comparison with ab initio potential energy surface collision studies.


1.2
0.8
0.4
0.0
TCPS Intensity (a.u.)
-5
0
5
10
15
20
Probe Detuning (cm-1)
P11(7.5) - P11(10.5)
P11(11.5 +6.5)
P11(12.5 +5.5)
P11(13.5 +4.5)
P11(14.5 +3.5)
P11(15.5 +2.5)
P11(16.5 +1.5)
Theory
Expt 1% NO-He